



TEST AND OVERHAUL

FUEL-INJECTOR NOZZLE

GE LARGE BENDIX SYSTEM

GE DRAWING 41C613567G1

GE PART 123X1041

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DESCRIPTION

The fuel-injector nozzle (Fig. 1) is located in the cylinder head and injects fuel oil directly into the cylinder. It consists of a nozzle body with a fuel inlet duct and drain duct, a nozzle valve assembly, spray tip, a valve loading spring, spring-pressure adjusting shims, and an assembly nut to hold the assembly together.

A rod, in contact with the top of the needle (valve), limits needle lift by contacting a hardened steel disc when the needle rises a designed distance off its mated seat.

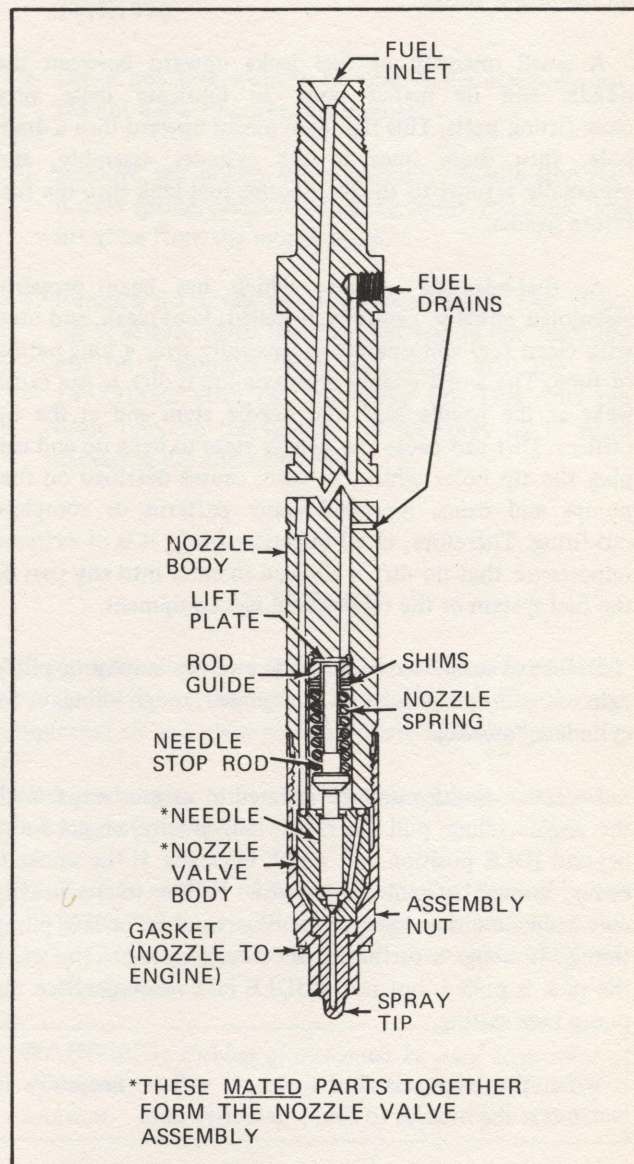


FIG. 1. FUEL-INJECTOR NOZZLE—SECTIONAL VIEW.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Verify numbers for parts, tools, or material by using the Renewal Parts or Tool Catalogs, or contact your General Electric representative for assistance. Do not order from this publication.

When the nozzle is open, fuel oil at high pressure flows down from the chamber between the needle and its seat to the spray tip, where it is dispersed thru ten small holes into the combustion chamber of the cylinder. The holes are only a few thousandths of an inch in diameter; thus the oil sprayed from them forms a fine mist which mixes with the hot, compressed air in the combustion chamber to form a quickly-ignited, combustible mixture. This mixture burns rapidly and produces pressure to drive the piston downward on the power stroke.

A small quantity of fuel leaks upward between the needle and its mated body to lubricate these very close-fitting parts. This fuel then passes upward thru a drain hole, thru drain lines in the cylinder assembly, and eventually returns to the locomotive fuel tank thru the fuel return header.

A fuel-injection nozzle which has been properly assembled initially, carefully installed, kept clean, and used with clean fuel will operate successfully over a long period of time. The worst enemy of nozzle life is dirt. It can cause wear at the needle seat, the needle stem and at the tip orifices. Dirt can cause the needle stem to hang up and can plug the tip holes which, in turn, causes overload on fuel pumps and cams, lop-sided spray patterns or complete mis-firing. Therefore, in all injection work, it is of extreme importance that no dirt is allowed to enter into any part of the fuel system or the fuel-system test equipment.

Defective nozzles may be indicated by smoky or puffy exhaust, dilution of lube oil, low power, rough idling, or by cylinders "missing."

Defective nozzles may be isolated in various ways. With the engine idling, pull the racks, individually, about 3 mm beyond IDLE position and watch the stack. If the smoke is heavy, arrange to pull the injector. Failure to fire heavily may indicate either injector or valve trouble, or late pump timing. Investigate further. If the nozzle seems to fire when the rack is pulled, but not at IDLE rack reading, check the pump rack setting.

When the engine is shut down, it will be necessary to bench-test the nozzles to find a defective one.

TESTING FUEL NOZZLES

EQUIPMENT REQUIRED

Bench Tester	Part 147X1149-1
Fuel Line	Part 147X1642
Connector	Part 147X1491

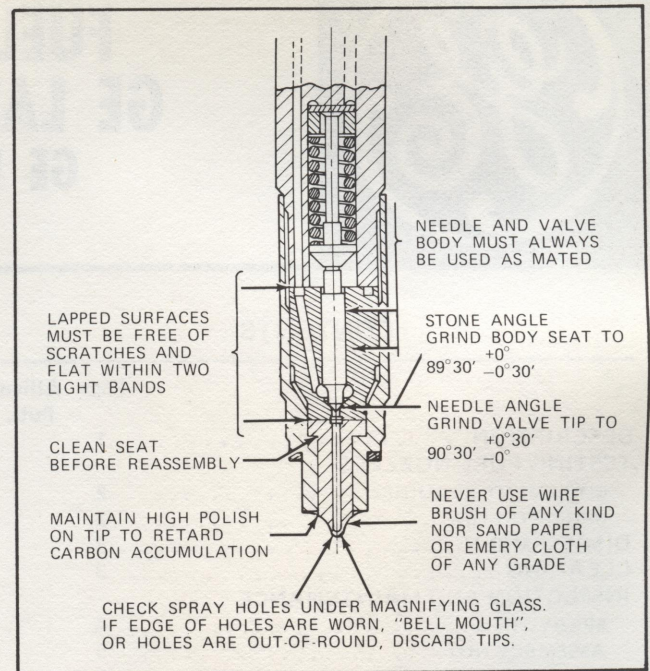


FIG. 2. ENLARGED VIEW OF FUEL NOZZLE.

BENCH TESTING

Follow these steps to pop-test fuel nozzles on the bench.

1. Assure the tank of the bench tester is filled with clean fuel oil and that the connector and test line are clean inside and out.
2. Set up the nozzle in the test stand and connect the fuel line and connector to inlet (See Fig. 3).
3. Operate the pump handle several times to fill the nozzle passages with oil and to eliminate air pockets.
4. Build up pressure to establish opening and closing pressures.
5. Observe the spray pattern and note the number (if any) of plugged and partially-plugged holes. Also note the quality of atomization.
6. Watch for after-dribble at the nozzle tip.
7. Watch for leakage at the assembly nut.
8. Watch for leakage at the leak-off hole. (The latter should not be more than a few drops per stroke.)
9. Failure of the nozzle at any of the above points will necessitate reworking of the nozzle.

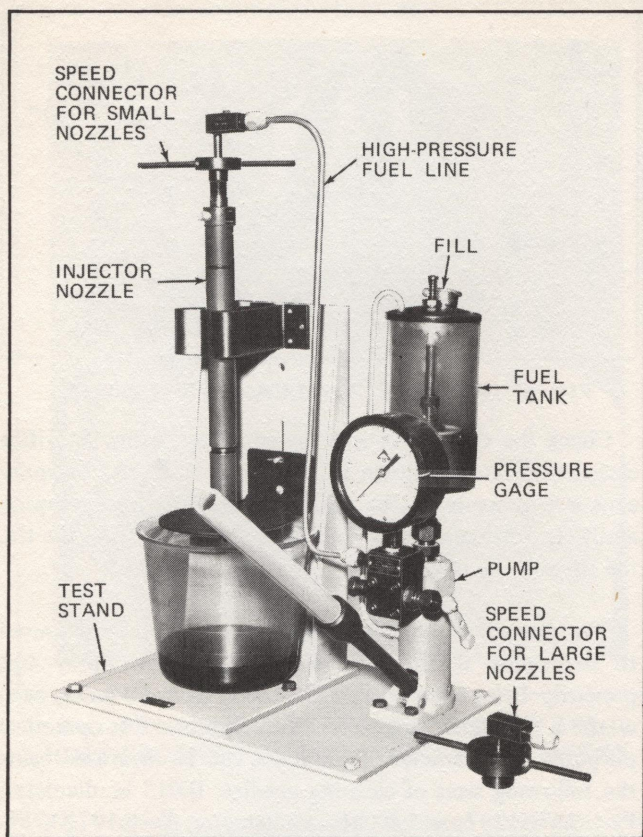


FIG. 3. NOZZLE TEST STAND.

The following additional test applies to new or reconditioned nozzles only.

Wipe the nozzle tip and build up the pressure to a point about 200 psi below the actual opening pressure. Watch for leakage drops at the tip. The tip should not drip in 10 seconds.

Note that while this test requires removal of the nozzle from the engine, it provides all of the necessary information about the nozzle at once.

Alternatively, nozzles can be pop-tested in place but this method will not show up partially-plugged tips, deficient atomization, or after-dribble.

Since a nozzle found to be defective has to be removed anyway, and then retested on the bench, no time saving is clearly evident when the nozzle is left in place. On the other hand, the danger of contaminating the fuel system with dirt is greater with removal of the nozzle.

DISASSEMBLY (See Fig. 1)

Follow these steps for disassembly of the fuel nozzle:

1. Place the nozzle body vertically in a vise, with the lapped surfaces upward. Using soft jaws on the vise, clamp the assembly across the body flats. Alternatively, secure nozzle body in holding fixture, Part 147X1970.
2. Use a hex box wrench to remove the assembly nut. Do not use a 12-point box wrench.
3. Remove the nozzle valve assembly, needle stop rod, nozzle spring, pressure-adjusting shims, rod guide, and lift plate from the nozzle body.
4. Remove the spray tip from the assembly nut. If the tip is seized, place the threaded end of the assembly nut on a wooden block and, using drift pin, Part 147X1002, drive out the spray tip. This drift pin bears only on the shoulder of the spray tip to avoid damaging the end of the tip.

CLEANING

Thoroughly clean and flush all parts with clean fuel oil, mineral spirits, or kerosene. Blow parts dry with dry, compressed air and place parts on clean, lintless paper.

Carboned spray tips can be cleaned by using the following method:

1. Dissolve one oz. of Bendix Spray Tip Cleaner**, Part 147X1785-1, per gallon of water and, with spray tips submerged in this solution, heat and boil for 10 minutes.

WARNING: Rubber gloves must be used to protect the hands when working with any decarbonizing solution.

2. Clean orifice holes with 0.015 in. diameter cleaning needles, Part 147X1787. See Fig. 6. Clean the internal hole with 0.067 in. diameter sequel cleaning drill, Part 147X1791.

*Revisions are indicated by marginal bars.

**Product of Bendix Electrical Components Division.

3. With a clean cloth, wipe spray tips to remove carbon and cleaning solution. Blow out cavities with clean, dry, compressed air.
4. Use a split-ring sleeve to hold the spray tip by its small outside diameter in a collet or chuck lathe. Rotate tip and polish entire nose portion of tip, first with crocus cloth, then with a small piece of hard felt charged with coarse lapping compound, Part 147X1148.

CAUTION: Do not use emery cloth or any form of wire brush to clean nozzle tips. This will cause "bell-mouthing" of the spray holes and will roughen the tip surface. A rough surface will hasten the accumulation of carbon, which causes engines to smoke and perform inefficiently.

5. Rinse spray tip in clean fuel oil and blow it dry with clean, dry, compressed air.

INSPECTION AND MAINTENANCE

SPRAY TIP

Place the spray tip under a magnifying glass to examine and clean the spray holes. Examine the spray holes to see if they are obviously worn. A spray tip which is badly worn will have holes which are elliptical or "bell-mouthed", rather than clean-cut with sharp edges. Fig. 4 shows a spray tip with clean-cut holes. Fig. 5 shows a badly-worn tip, where the edges of the holes have been worn by erosion or improper cleaning and have become "bell-mouthed." Tips worn to this degree should be renewed. Spray tips having spray holes with fairly square edges may be reused providing they pass the size and air flow test.

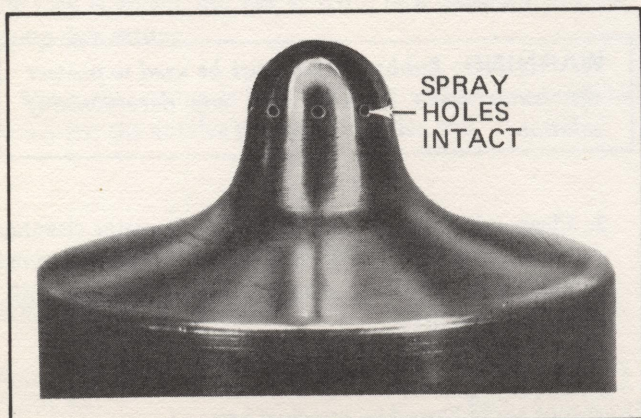


FIG. 4. PROPERLY—CLEANED SPRAY TIP.

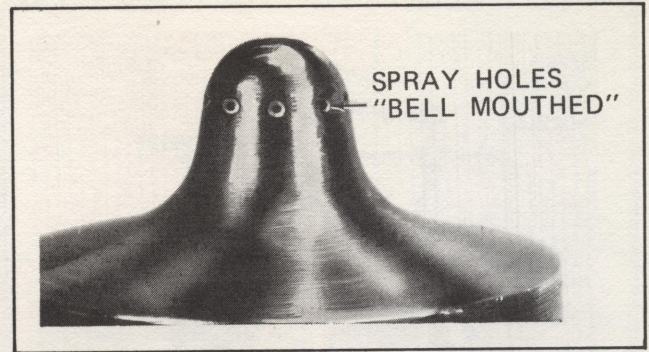


FIG. 5. IMPROPERLY—CLEANED SPRAY TIP.

Check the size of holes in the spray tip, using an orifice cleaning needle as shown in Fig. 6. Do not bend or apply excessive pressure to the needle as it can be broken quite easily. If a broken needle cannot be removed from the tip, the tip must be discarded.

The diameter of spray tip openings should be measured to determine if tips are excessively worn. Spray tips presently being used (Part 123X1053) have 10 holes, each with a nominal diameter of 0.016 in. For practical purposes, the diameter of the holes can be measured using the following sizes of cleaning needles: 0.015 in. diameter, Part 147X1787, and 0.016 in. diameter, Part 147X1788. The 0.015 in. needle should pass thru all spray holes. If any of the spray openings are large enough to permit passage of the 0.016 in. needle, the tip should be renewed.

Spray tips can be checked additionally for correct orifice sizing by applying an air flow test using Part 147X1884 tester.

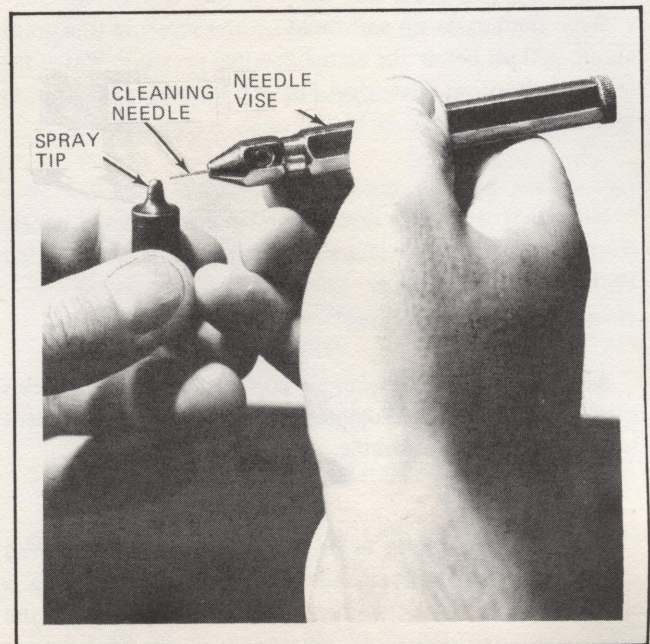


FIG. 6. CLEANING SPRAY TIP HOLES.

FIG. 4, E-6573

FIG. 5, E-6574

FIG. 6, E-7451B

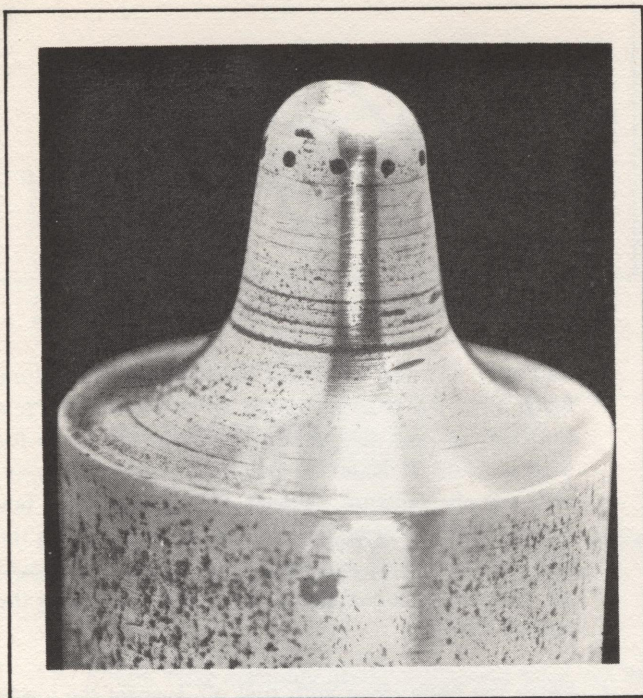


**FIG. 7. CARELESSLY—HANDLED SPRAY TIP.
NOTE EROSION PITS, NICKS AND SCORE MARKS.**

Fig. 7 shows a spray tip with distorted holes caused by careless handling. The tip was finished, leaving a very coarse surface and circular score marks. The edge of the spray hole was nicked, causing its spray to be distorted.

ASSEMBLY NUT

Inspect for cracks, damaged threads, or damage to the gasket-sealing surface. If carbon is present in the spray-tip hole, remove with a hand reamer or twist drill of proper size. Use a soft wire brush and fuel oil to thoroughly clean the inside of the assembly nut. Flush with clean fuel oil and blow dry with clean, dry, compressed air.

Fit a spray tip in the assembly nut. Spray tip must enter the bore of the nut freely and must bottom, metal-to-metal, in the bore shoulder.

ROD GUIDE AND SHIMS

These are reusable and need replacement only if severe wear or damage is noted.

NEEDLE STOP ROD

Reuse unless length is less than 1.743 in. See Fig. 10.

NOZZLE BODY

Inspect the fuel passages for contamination using an Otoscope, Part 147X1172. Check depth of cavity in the lower end of the body, which must be 2.081 to 2.095 in. when measured with a depth micrometer. See Fig. 11.

NOTE: *Body may be reworked to increase cavity depth, providing the machining does not pass the relief groove in the bottom of the cavity.*

NOZZLE SPRING

Replace if found to be broken or corroded. Correct spring pressure is verified when proper opening pressure is attained when pop-testing the nozzle.

FLAT LAPPED SURFACES

These surfaces are: the lower face of the nozzle body, both faces of the nozzle valve body, and the top face of the spray tip.

Examine for scratches, nicks, and lacquer deposits. If found, use a lapping machine or a manual-type lapping block to refinish these surfaces. Remove only minimum stock from parts. Lapped surfaces must be flat within two light bands, using a monochromatic light and an optical flat.

NOZZLE VALVE ASSEMBLY

The needle and its nozzle valve body must always be kept together, since they are fitted together as a matched set by the manufacturer.

Prolonged operation of any nozzle-valve assembly with dirt in the valve-seat area will cause indentations on the seating surfaces, and these must be refinished to provide a leak-free seal.

The most common causes of needle and valve body scoring are water, dirt, and high sulfur content in the fuel used.

Scored surfaces in the cylindrical fit between the needle and its body cause loss of opening pressure, and the whole nozzle valve assembly must be replaced.

If the needle sticks slightly in the bore of its body, it may be due to a lacquer deposit on the lapped cylindrical surfaces. This lacquer may not be visible, but can be detected by rotating the dry needle in a paper towel; if lacquer is present a squeaky noise will be heard. Remove lacquer deposits in the following manner:

1. Secure stem of needle in a lathe so its companion body will not come closer than 1/16 in. from the chuck when the body is fitted over the needle.
2. Apply a small amount of fine lapping compound, Part 147X1147, to the outer surface of the needle.
3. Fit the body over the needle, and rotate it a few times with an oscillating back-and-forth movement.
4. Set up lathe to rotate at 1750 rpm maximum speed. Start lathe while holding body firmly and, at this same time, oscillate the body lengthwise on the needle. Continue this operation only until the body loosens slightly on the needle.
5. Thoroughly rinse and flush needle and body to remove all lapping compound. After thoroughly cleaning the body and its companion needle, assemble the needle into the body bore. The needle should slide freely, by gravity only, into the body when the body is held at a 45-degree angle.

Nozzle Valve Body

Inspect the seat for erosion, contamination or dents. If found, hone the seat in the following manner:

1. Two kinds of pencil-honing stones are available for this operation. They are Part 147X1500 and 147X1501 stones; they differ only in the diameter of their shanks. Select the stone with the largest shank diameter that will fit in the body bore and still allow free rotation.
2. Check angle of honing stones, using Nozzle Viewer, Part 147X1390-1 or 147X1451-1. Maintain the correct stone angle, redressing the stones as required. Refer to Fig. 8.
3. Secure the stone's shank in a bench lathe. Run the lathe momentarily to assure the stone runs true. Stop the lathe and apply honing oil to the stone and shank. This will serve as a cutting oil, as well as a lubricant to protect the inside lapped surfaces of the body.

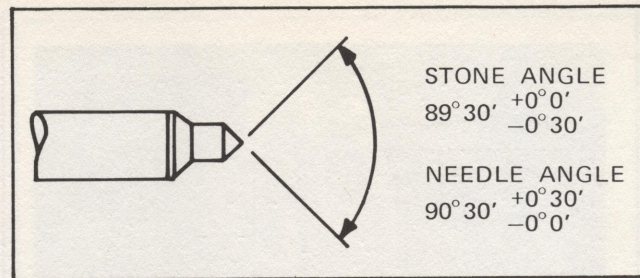


FIG. 8. HONING STONE AND NEEDLE ANGLES.

4. Carefully slide the body over the stone until the stone seats. Turn the lathe at speeds up to 3450 rpm. Press the body so that the seat bears against the stone for 5-10 seconds. Release the pressure, rotate the body, and reapply pressure. Repeat this procedure a few times. Stop the lathe and remove the body. Clean the body with fuel oil and blow it dry with compressed air. Inspect for a completely refinished seat, using the Nozzle Viewer.
5. Flush the body clean with fuel oil. Inspect the inside of the body with an otoscope and assure it is free of all lapping compound.

Needle

If necessary, grind the flat end of the needle to eliminate scratches or signs of uneven wear. This surface must be square with the axis of the needle. It will be necessary to grind the needle seat if the nozzle-body valve seat has been honed. Grind the needle seat to the angle shown in Fig. 8. Do not grind more than is necessary to refinish the seating surface. Check the needle angle with the Nozzle Viewer.

This angle differential between mating needle and body is extremely important.

If there are any burrs or fins on the top large diameter of the needle, remove them with a fine stone while rotating the needle in a spindle. Keep the lapped surface of the needle clean by wrapping it in a clean paper towel.

NEEDLE LIFT

The amount of needle lift is important to effect proper nozzle valve action. Needle lift is affected by:

1. Length of needle protrusion
2. Length of needle stop rod
3. Depth of nozzle body cavity
4. Thickness of lift plate.

FIG. 9, E-15103A

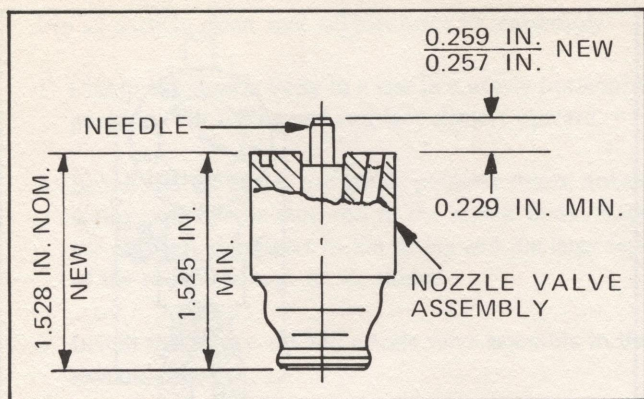


FIG. 9. MEASURING NOZZLE VALVE NEEDLE PROTRUSION.

These parts must be inspected and corrected, where necessary, before needle lift and adjustments are made.

The nozzle valve assembly needle protrusion must not be less than 0.229 in., or the valve assembly must be replaced. Do not remove excessive material from ends of nozzle valve body, because this is a case-hardened part. Surfaces are to be lapped only. Refer to Fig. 9. Minimum body length is 1.525 in.

The needle stop rod must be maintained at proper length. If the length of the rod is less than 1.743 in., it must be replaced. See Fig. 10.

Measure the depth of the nozzle body cavity with a depth micrometer. The depth of this cavity must be 2.081 to 2.095 in. See Fig. 11. Normal lapping of the body end face will reduce the depth of this cavity. If it is below the specified dimension, the depth can be increased by using an end mill or boring tool; however, do not machine past the relief groove as noted in Fig. 11. This groove is to allow passage of normal fuel leakage from the nozzle valve assembly.

FIG. 12, E-15106A

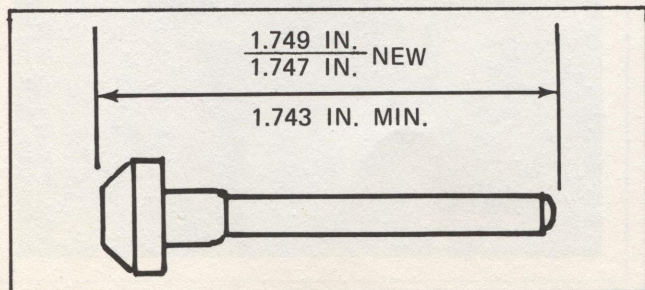


FIG. 10. NEEDLE STOP ROD.

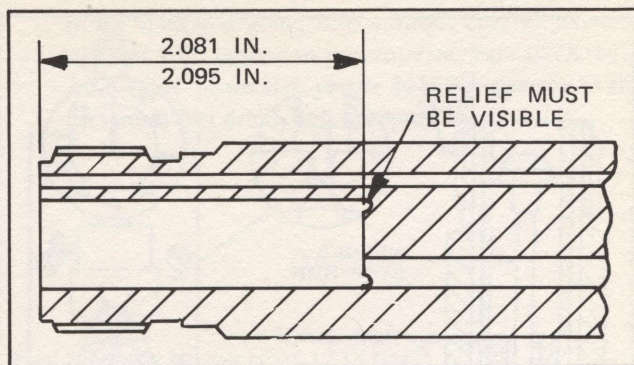


FIG. 11. NOZZLE BODY.

Needle lift now can be checked. Using a depth micrometer, measure the distance from the body-end face to the needle-stop rod face, when the stop rod is placed in the body cavity (less spring) with the lift plate and guide installed. See Fig. 12-A. This dimension, minus the amount of needle protrusion, is the needle lift. See Fig. 12-B. The "X" dimension minus the "Y" dimension is the lift. The needle lift required is 0.017 to 0.024 in.

Needle lift also can be measured by a direct-reading method utilizing needle lift gage, Part 147X1171. See Fig. 15. A special anvil is included with this gage which will permit direct lift reading.

When using the lift checking gage, the following procedure should be used:

1. Install a new lift plate, rod guide and needle-stop rod in the nozzle body cavity. Do not install the nozzle spring. See Fig. 13-A.
2. While holding the needle against the valve seat, place the anvil into the outlet of the nozzle to contact the needle point. Zero the gage. See Figs. 13-B and 15.

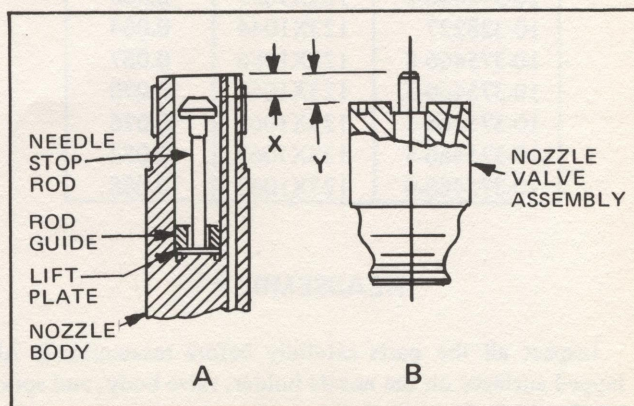


FIG. 12. MEASURING NEEDLE LIFT.

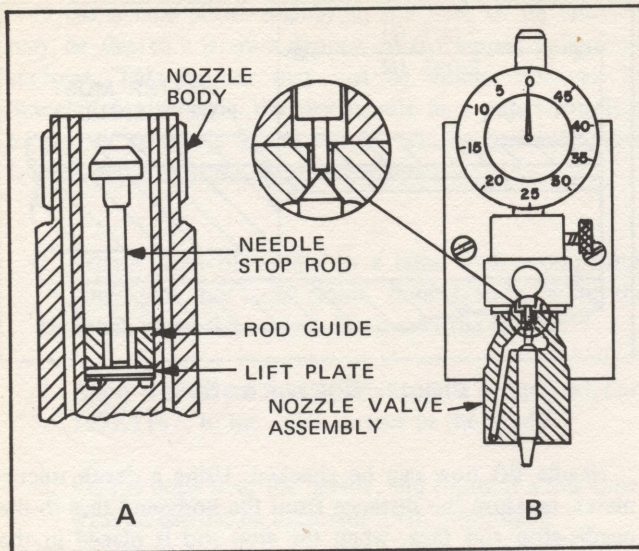


FIG. 13. PREPARATION FOR MEASURING NEEDLE LIFT.

Place the nozzle-valve assembly on the nozzle body in the normal operating position, and read the indicated lift as shown in Fig. 14. The lift must be 0.017 to 0.024 in.

Normal operation and repair will increase the amount of needle lift. In order to maintain the specified lift, a selection of lift plates has been made available. Refer to Table I. Select the plate necessary to provide a lift dimension of 0.017 to 0.024 in. New holder assemblies will have a 0.067-in. plate installed (Part 123X1086).

NOTE: Lift plates should always be replaced at overhaul.

TABLE I, LIFT PLATE DIMENSIONS

Bendix Part	GE Part	Thickness (In.)
10-375466-1	123X1058	0.052
10-375466-2	123X1059	0.058
10-328227	123X1044	0.064
10-375466-8	123X1086	0.067
10-375466-3	123X1060	0.070
10-375466-4	123X1061	0.076
10-375466-5	123X1062	0.082
10-375466-6	123X1063	0.088

REASSEMBLY

Inspect all the parts carefully before reassembling. All lapped surfaces on the nozzle holder, valve body, and spray tip should be free of all defects. The fuel inlet connection and passages must be free of dents, burrs, or grooves.

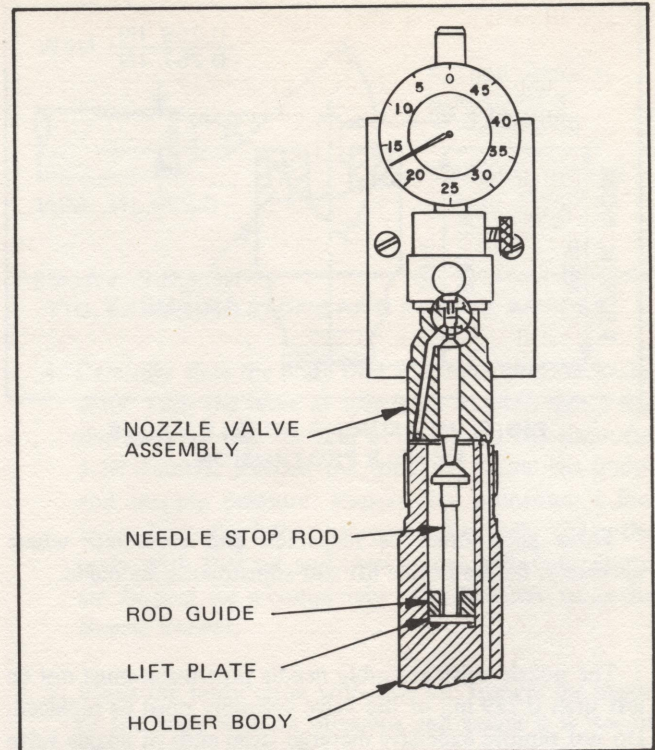


FIG. 14. MEASURING NEEDLE LIFT.

An extremely important factor in assembling fuel nozzles is cleanliness. Have clean hands, use clean fuel oil, and blow out each item with air. Fits or tolerances in fuel-injection equipment are extremely close, and dirt which cannot be seen by the naked eye may lead to damage of the equipment.

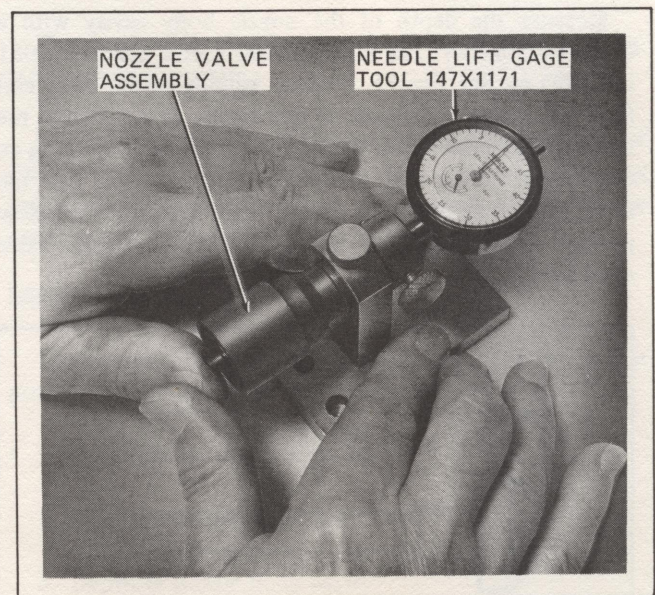


FIG. 15. GAGE SET-UP PRIOR TO MEASURING NEEDLE LIFT.

FIG. 13, E-15107A

FIG. 14, E-15108A

FIG. 15, E-25025

Dip all parts in clean fuel oil just prior to reassembly.

1. Clamp the nozzle body in a vise in a nearly horizontal position. Tilt the lapped end face slightly upward.
2. Install the lift plate, rod guide, pressure shims, nozzle spring, and needle stop rod in the nozzle body. Place the thickest shim next to the spring and the large face of the rod guide next to the shims.
3. Install the spray tip and nozzle valve assembly in the assembly nut.
4. Start the assembly nut on the nozzle body, and tighten it with a hex box wrench to the value listed in the DATA section.
5. Check the opening pressure by pop-testing per instructions given previously in TESTING FUEL NOZZLES section. Check for leaks at the assembly nut. If fuel leaks around the nut, it indicates poorly-lapped surfaces, dirt between surfaces, or possible cracked parts.
6. If the pressure is not as listed in the DATA section, adjust the pressure by adding or removing shims. Retest until the specification is met.

7. If the nozzle is going into storage, coat all exposed surfaces with corrosion preventative, Part 147X1615. Also apply protective plastic or paper devices to the fuel inlet, fuel drains and the spray tip.

DATA

Fuel-Injection Nozzle (Part 123X1041)

Nozzle Valve Opening Pressure —

Normal (psi) 3000-4000*

**NOTE: The 3000-psi opening pressure should be considered the condemning limit for continuing a nozzle in service.*

Nozzle Valve Opening Pressure (New or

Reconditioned) Set to Open at (psi) 3800-4000

Needle Lift (in.) 0.017-0.024

Nozzle Spray Tip

(Part 123X1053) 10 holes — 0.016 in. diameter

Torque Values

Nozzle Assembly Nut (lb.-ft.) 130-150